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OF THE

SLEEPING SICKNESS COMMISSION.

No. V.

9. A Provisional List of Diptera, etc. By ERNEST E. AUSTEN.

10. Further Observations on the Trypanosomiases (Human and Animal) in Uganda. By DAVID NABARRO, M.D., and Capt. E. D. W. GREIG, I.M.S.

LONDON:
HARRISON AND SONS, ST. MARTIN'S LANE,
PRINTERS IN ORDINARY TO HIS MAJESTY.

Price Three Shillings.

JULY, 1905.

Acad. Lond.

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1957

9.

A PROVISIONAL LIST OF DIPTERA, ETC.,

Forwarded from Uganda by Lieut.-Colonel BRUCE during the Investigations of the Sleeping Sickness Commission.

By ERNEST E. AUSTEN, Zoological Department, British Museum.

[Sent in November 9, 1903.]

The following list represents no more than the result of a preliminary examination of the material already received. Since collections of blood-sucking and other Diptera are still being made under the supervision of Dr. Nabarro and Captain Greig, it has been thought advisable to defer the final *working-out* of the material at present available, with the description of new species, until the conclusion of the investigations of the Sleeping Sickness Commission. Owing to the fact that the bulk of the material forwarded by Colonel Bruce was obtained by unskilled native collectors, it is unfortunately not in the best of condition, and many specimens will certainly prove to be too much damaged to determine or describe. In view of the increased importance which now attaches to Diptera as transmitters of disease, it cannot be too strongly urged that a competent Dipterist should be included in the *personnel* of any future expedition for the investigation of maladies which there may be reason to suppose are disseminated by means of insects belonging to this Order.

FAMILY CHIRONOMIDÆ.

Ceratopogon sp. nov. [B]*. Mianga river: July 11, 1903.

FAMILY CULICIDÆ.

Toxorhynchites brevipalpis, Theob. [B]. Entebbe: in house.

FAMILY SIMULIDÆ.

Simulium sp. nov. [B]. "Mbwa-fly," Kyagwe.

* The letter [B] in square brackets, following the name of a species, indicates that it is a *blood-sucking form*.

Family Tabanidæ.*

Chrysops stigmaticalis, Lw. [B]. Busoga.
„ *sp. nov.* [B].
„ *sp. nov.* [B].
Hæmatopota—several species, all apparently new [B].
Tabanus rubicundus, Walk. [B].
„ *latipes*, Macq. [B]. Buvuma Island: from long grass.
„ *biguttatus*, Wied. (or closely allied species) [B]. Busoga: from swamp.
„ *fasciatus*, Fab. (or closely allied species) [B]. Bugaya Island: shore of lake.
„ *sp.*, nearly related to *T. fasciatus*, Fab. [B].
„ ? *rufipes*, Macq. [B].
„ *sp.*, nearly related to *T. pervasus*, Walk. [B].
„ ? *socius*, Walk. (*serratus*, Lw.) [B].
„ several species, as yet undetermined [B].

Family Asilidæ.

Promachus fasciatus, Fab.†

Family Nemestrinidæ.

Colax sp., probably new. Bulemwezi: from grass lands.

Family Dolichopodidæ.

Psilopus carus, Walk. Entebbe: in laboratory.

Family Syrphidæ.

Syrphus adligatus, Wied. Chagwe.
Asarkina ericetorum, F.
Eristalis tæniops, Wied. Busoga; Jinja: from swamp.
Helophilus—two species, ? new. Busiro: from grass by a stream.
Megaspis sp., probably new (near *Megaspis curtus*, Lw.).
Plagiocera maculipennis, Lw. Busoga: near river.
Genus et sp. nov., allied to *Plagiocera*.
Microdon brevicornis, Lw. Entebbe: in laboratory.

Family Muscidæ.

Auchmeromyia luteola, Fab. (*Ochromyia senegalensis*, Macq.). Bulemwezi.‡
Zonochroa fasciata, Macq. Bulemwezi and Bukoba: from long and short grass.

* It will be observed that no examples of the genus *Pangonia* were received.

† This species also occurs in West Africa.

‡ This species ranges from Somaliland to Natal, and is also found in West Africa. In Nyasaland it is known from the mouth of the Zambesi up to the Shire Highlands.

Zonochroa spp., probably new.
Phumosia trifaria, Big. Bulemwezi: from grass and banana plantations.
Glossina palpalis, Rob.-Desv. [B].
,, *pallidipes*, Austen* [B].
Pycnosoma marginale, Wied. Bulemwezi.
,, *sp.*, near *P. marginale*, Wied.
,, *chloropyga*, Wied. Bulemwezi; Chagwe.
Pseudopyrellia sp.
Lucilia sp.
Genus et spp. (2) *nov.*, near *Rhynchomyia*.
Musca sp., near *Musca domestica*, Linn.
Dejeania bombylans, Macq. (? Fab.)
Orectocera diabolus, Wied. Bulemwezi.
Tachina sp., probably new.
Tricholyga sp.
Micropalpus sp., ? new. Bulemwezi; Busiro: from grass by a stream.
Exorista sp., Bulemwezi; Chagwe: from grass lands.
Sarcophaga spilogaster, Wied. Chagwe.
,, *sp. incert.*
Mydæa sp. incert. Kyadondo: from grass on lake shore.

Family Ortalidæ.

Platystoma sp., probably new (near *Pl. punctipenne*, Walk.). Bulemwezi: from grass by a stream.

Family Trypetidæ.

Ceratitis sp., near *C. cosyra*, Walk. Kyadondo; Mengo: inside compound.

Family Ephydridæ.

Dryxo sp., probably new.
Genus et sp. incert. Mitala Maryia: in papyrus swamp.

In addition to the Diptera, as enumerated above, the collection sent home by Colonel Bruce included a certain number of specimens of other Orders of insects, besides examples of two species of ticks. The names of these miscellaneous specimens are given below: they have been kindly determined by Lieut.-Colonel Bingham (Hymenoptera), Mr. W. F. Kirby (Orthoptera and Neuroptera), Mr. C. J. Gahan (Coleoptera), and Mr. R. I. Pocock (Ixodidæ).

* This species, together with *Glossina fusca*, Walk. [B], *Gl. longipennis*, Corti [B], and *Stomoxys tæniatus*, Big. [B], was also taken at Kibwezi, British East Africa, "in thorny bush."

ORTHOPTERA

Anisolabis angulifera, Dohrn. Bulemwezi: from banana plantation.

NEUROPTERA ODONATA.

Palpopleura portia, Dru.
Ictinus ferox, Ramb.
Brachybasis rhomboidalis, Beauv.

COLEOPTERA.

Aspidomorpha tecta, Boh. Entebbe: in house, on flowers.

HYMENOPTERA.

Chalicodoma cœlocera, Smith.
Oxybelus arabs, Lepel.
Crocisa emarginata, Lepel.
Megachile ianthoptera, Smith.
Xylocopa olivacea, Fab.
„ *sp.*, near *X. cyanescens*, Brullé.
„ *sp. incert.*
Bembex sp.
Chrysis lyncea, Fab.

ARACHNIDA.

ACARINA.

FAMILY IXODIDÆ.

Amblyomma sp. [B], near *A. hebræum*, Koch. Entebbe: from a sheep.
Ornithodoros moubata,* Murray [B]. Jinja.

APPENDIX.

Since the above lists were prepared I have received from Dr. Nabarro some additional material, including—

i. A large series of specimens of *Glossina palpalis*, Rob.-Desv. [B].
ii. Nineteen pupæ of the same species.

* A tube containing adults and young in formalin, accompanied by the following note:—"A bottle containing ticks named *Kibu*. They are found on the lake shore. Their bite causes inflammation with high fever, and I am told that in some cases the effect is fatal."—(W. Grant.)

iii. A series of specimens of two species of *Stomoxys** [B].

iv. A series of specimens of two species of *Musca*, one closely resembling *Musca domestica*, Linn., but distinct; the other much smaller, and possibly referable to a separate genus, since it is remarkable for the thickness of its proboscis.

The pupæ of *Glossina palpalis* are in all essential characters precisely similar in form and appearance to those of the Zululand tsetse, as figured on p. 27 of the author's "Monograph of the Tsetse-Flies" (1903). The tumid lips at the posterior extremity, however, are somewhat larger and much closer together, so that the space between them is much narrower. When this difference has once been observed, it is most noticeable, so that by means of it the pupæ of the two species are readily distinguishable. It would be interesting, from this point of view, to be able to compare the pupæ of all the species of *Glossina*, but at present material for this purpose is lacking, and these are the only species of which pupæ have so far come to hand. In size, the pupæ of *Gl. palpalis* are slightly smaller than those of the Zululand species, the specimens sent varying in length from $5\frac{1}{4}$ to $6\frac{1}{3}$ mm.

* Neither of these is *Stomoxys tæniatus*, Big., recorded above (p. 5, note *) as having been taken at Kibwezi, British East Africa. The two species now sent, or others so closely resembling them as to be indistinguishable on a cursory examination, are already represented in the British Museum collection by specimens from Pemba Island, East Africa, August, 1899 (D. R. O'Sullivan Beare). The names of the species, which are very possibly new, must be left for future determination.

10.

FURTHER OBSERVATIONS ON THE TRYPANOSOMIASES (HUMAN AND ANIMAL) IN UGANDA.

By DAVID NABARRO, M.D., and CAPT. E. D. W. GREIG, I.M.S.

(Dated Entebbe, November 20, 1903.)

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Introductory.

After Colonel Bruce's departure from Uganda on August 28, 1903, we continued the investigations of the Commission on human trypanosomiasis, and studied more in detail certain animal diseases which were associated with the presence of trypanosomata. An attempt was made to ascertain whether these trypanosoma diseases in animals were identical with Nagana or Surra, or whether they were new to medical and veterinary science. Our experiments, as recorded in this Report, are not sufficiently numerous or far advanced to enable us to state definitely whether we have been studying the *Trypanosoma brucei* or *Trypanosoma evansi*, or whether any of the parasites investigated were new species (Section I).

We also continued the observations upon several Sleeping Sickness patients, and have reported a typical case occurring in a Persian which, at the time of writing the Report, we thought to be the first instance on record of the disease attacking an individual who was not a native of Africa. About the same time, although we heard of it only long afterwards, Sir P. Manson's patient (a European missionary), who had had trypanosomata in her blood for many months, died in England of Sleeping Sickness.

Amongst the patients we had under observation was a boy who suffered from recurrent attacks of fever, rather like Relapsing Fever. He was sent up as a case of Sleeping Sickness, but we could get no cerebro-spinal fluid on lumbar puncture. On examining his blood, spirochætes were found on at least two occasions, and as this was the first undoubted case of "Spirochæte" Fever occurring in that part of the world, we thought it worth putting on record. Since our case which was under observation in August, 1903, Drs. Hodges and Ross, of the Uganda Medical Service, have had other cases in native Waganda and in Indians domiciled in Uganda, which have been reported in the medical journals.

We have kept under observation and examined from time to time the five natives suffering from so-called "Trypanosoma Fever," whose cases were given in the earlier reports of the Commission. One of them, Bara Risgallah, when out in charge of a gang of prisoners

one day towards the end of October, 1903, was found sound asleep on the ground and was aroused with difficulty. This was the first time that he had manifested any signs of Sleeping Sickness, if, indeed, this occurrence is to be looked upon as such at all or merely an accident.

The four other patients continue in apparently good health. Since Colonel Bruce's departure, we have failed to find trypanosomata in the cerebro-spinal fluid of J. Murjan and K. Barigi, who had previously both shown them on two occasions.

Two of our young experimental dogs developed a piroplasmosis which proved fatal in both cases. Advantage was taken of the occurrence to study the effect of injection of the infected blood from these puppies into an adult dog and a monkey. Both animals developed piroplasmata in the blood and had albuminuria. The dog died after five weeks.

We have found during our continued observations on the experimental monkeys that after some time immunity is apparently produced, and that a repeated injection of the same trypanosoma (either the blood or the cerebro-spinal human trypanosoma) fails to produce the reappearance of the parasite in the peripheral blood two or more weeks after the injection.

We have arranged to inject these "immunised" monkeys with the other variety of trypanosoma to see whether *it* will develop in their blood, for if it do not, it will tend to prove that the trypanosomata occurring in the blood in "Trypanosoma Fever" and in the cerebro-spinal fluid in Sleeping Sickness are identical (Section II).

We also endeavoured to ascertain whether there is a specific carrier for each variety of trypanosoma. Our experiments seem to negative this idea, for we found that the *Glossina palpalis* was able to convey, by feeding, at least two of the animal trypanosomata from infected to healthy monkeys. Experiments with other biting flies, such as Stomoxys and Tabanidæ, yielded negative results, the former apparently being unable to convey trypanosomata to healthy animals by feeding, while the latter refused to feed when in captivity and soon died off.

Dissections of flies (Glossinæ and Stomoxys) at varying intervals after a feed of blood containing trypanosomata, yielded interesting results. It was found that the trypanosoma of Sleeping Sickness was motile in the stomach contents of *Glossina palpalis* 71 hours after a feed. The various animal trypanosomata were found active 100 hours, $5\frac{1}{2}$ hours and 20 hours respectively in the stomach contents of Glossinæ, whereas the same three animal parasites were found active in the stomach contents of Stomoxys 24 hours, 12 hours and 30 hours respectively after a feed (Section III).

The very important question whether the trypanosoma of Sleeping

Sickness can be conveyed by the tsetse flies met with in the East Africa Protectorate must apparently be answered in the positive, as the result of our experiments. Owing to the importance of this question and to the possibly far-reaching consequences of the importation of infected natives from Uganda into an area where the carriers of infection exist, these experiments are to be, or already have been, repeated (Section IV).

Finally, we have given some additional data concerning the distribution of tsetse flies in Uganda, notably in the region of the Albert Nyanza, the whole of which lake appears to be surrounded by a "fly" area (Section V).

Section I.—Trypanosomata Found in the Lower Animals in Uganda and East Africa.

While the Sleeping Sickness Commission was carrying on its investigations on the human trypanosoma, it was discovered that several species of lower animals suffered from trypanosoma infections. Experiments were therefore carried out to ascertain whether these animal trypanosomata bore any relation to the trypanosomata found in the human subject.

For the purpose of reference we have numbered the trypanosomata T. I, T. II, etc., until their identity or otherwise has been established:—

T. I is the trypanosoma found in Sleeping Sickness in the cerebro-spinal fluid.

T. II is the trypanosoma found in the blood of the patients Jardien Murjan, Karala Barigi, Kamsar Sabba, Bara Risgallah, and Tabula. (See Earlier Reports of the Commission.)

T. III is the trypanosoma found in the blood of sick transport cattle (oxen) in Entebbe.

T. IV is the trypanosoma found in the blood of a large herd of sick cattle at Jinja, Busoga.

T. V is the trypanosoma found in the blood of a dog which was sent up to us from East Africa.

T. VI is the trypanosoma found in the blood of a sick mule in Entebbe.

(a) *A Trypanosoma Occurring in Diseased Oxen in Entebbe, Uganda.* (T. III.)

On June 3, 1903, three government oxen were examined because they were out of condition. Trypanosomata were found in blood films of one (Experiment 152), but not in films of the other two.* Of the latter, one showed trypanosomata on centrifuging 10 c.c. of blood, while the other did not.

* See Reports of the Sleeping Sickness Commission, No. IV, pp. 47 and 48.

On inquiry it was ascertained that these oxen came from the East Africa Protectorate towards the end of 1900, passing through Busoga about September, 1900. They kept remarkably well in Entebbe until they were placed near the forest.

On August 13, the ox which had previously shown trypanosomata in films, was again brought up to the laboratory, this time time nothing more than a hide-bound skeleton. No trypanosomata were seen in a cover-glass preparation, but three days later, many were found on centrifuging 10 c.c. blood. A dog which had been injected with some of the blood on June 3, and which failed to show the trypanosoma in its blood, was reinjected on August 16, and again failed to develop trypanosomata in its blood. The ox went slowly down hill and died on September 28, and in spite of several examinations of 10 c.c. of blood, no trypanosomata were seen after August 16.

On September 5 the superficial lymphatic glands were greatly enlarged, and the animal was seen by a local trader, who said the disease was known locally as "Mukebi." While Colonel Bruce was in Entebbe, we had examined several animals in the last stages of this disease, and failed to find trypanosomata in 10 c.c. of blood.

On September 8, six other transport oxen were examined, but no trypanosomata were found in any of the blood films. The animals examined were all thought to be healthy.

On October 14, blood films of two sick oxen were examined, but no trypanosomata found.

The interesting points about this trypanosoma are (1) that it became very scanty in the blood of the sick ox towards the end of life, and could not be demonstrated during the last six weeks even by the centrifuge; (2) that the trypanosoma did not appear in the blood of a dog injected with the ox blood, although so numerous in the latter as to be seen in cover glass preparations.

Experiment 152. Transport Ox, Entebbe. (T. III.)*

Came from East Africa about end of 1900.

June 3, 1903. Animal seedy and brought to the laboratory. Trypanosomata found in cover glass preparations. Dog 128 injected. Animal returned to work.

August 13. Animal again brought up to the laboratory, a "hide-bound skeleton." No trypanosomata found in cover glass preparations.

August 16. Trypanosomata found in numbers on centrifuging. Injected dog 128 again.

August 19. Trypanosomata absent from films.

September 5. Animal is getting gradually thinner. The superficial lymphatic glands are greatly enlarged, and the ox looks like a typical

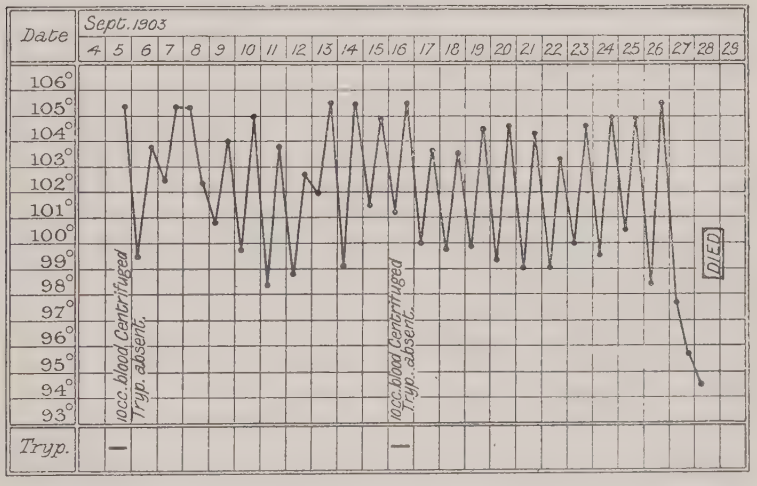
* See Reports of the Sleeping Sickness Commission, No. IV, p. 48 and Plate 2.

case of "Mukebi." About 30 c.c. blood centrifuged, but no trypanosomata found. Lumbar puncture was performed, but only blood obtained.

September 16. Blood again examined by centrifuge, but no trypanosomata found.

September 28. The ox has been gradually getting weaker, but until yesterday was able to walk about and graze with the other cattle. This morning his temperature fell to 94°·6 F., and he was unable to walk. He died at 11.30 A.M. Some blood was taken at death and injected into a dog, 207, and a monkey, 206.

The following chart represents the temperature curve from September 5 till death. No temperature observations were made before September 5.



Post-mortem immediately after death. Animal emaciated. Superficial lymphatic glands enlarged and congested on section. A little jelly-like material present in the subcutaneous tissues. On opening the body, a little clear fluid escaped from the pericardial cavity; none from the pleural or peritoneal cavities. The heart was pale; had yellow jelly-like material at the base, and on section two small petechiæ in the left ventricle. The lungs were healthy. The liver contained two flukes, but was otherwise normal. The gall bladder was distended with bile. The spleen was slightly enlarged. The kidneys were pale, but otherwise healthy. The retroperitoneal and mesenteric glands were only slightly enlarged. There was opacity of the left cornea, none of right.

Remarks.—Two injections of blood from this ox into a dog failed to infect the dog, although it received many trypanosomata on each occasion. The disease is therefore not Nagana in all probability, but its

trypanosoma may be closely allied to, if not identical with, that of human trypanosomiasis. The injection of blood, taken from the ox *post-mortem*, into a dog and a monkey yielded negative results, but it must be remembered that centrifuging 10 c.c. or more of the ox blood failed to show the presence of trypanosomata at any time during the last six weeks of the animal's existence.

(b) *A Trypanosoma Occurring in Diseased Cattle at Jinja, Busoga* (T. IV).

These cattle were brought in from the Bukedi country about May, 1903. They came from Wamia's district, to the south-west of Mount Elgon. On the way from Bukedi to Busoga they halted at Igagas, Kibue, Baleale, and Kitindis, in all of which places a tsetse fly (*Glossina pallidipes*) is found. When first brought into Jinja the cattle were apparently healthy, but later on died at the rate of five or six a day. The duration of the disease, as gathered from local information, is possibly two to three months.

Symptoms.—Animals are thin but not markedly emaciated. Anæmia is marked. Some slight enlargement of the lymphatic glands. The animals die often quite suddenly and in fairly good condition. Sometimes they waste, dying for several days.

Post-mortem.—The cervical glands are slightly enlarged and congested, sometimes hæmorrhagic. The supra-clavicular glands are also enlarged and congested. In some cases there is an increase of fluid in the pericardial and pleural cavities. The heart has yellow jelly-like material at the base and often petechiæ on its external and internal surfaces. Lungs are normal. The urine is clear. Kidneys and liver healthy. The spleen is slightly enlarged.

The native name of the disease is "Sutoko" and it has been thought to be an internal form of "Mukebi." When only the external glands are enlarged, many cases are said to recover. We examined several cases of so-called external "Mukebi" and were unable to find trypanosomata in any of the blood films taken. The native treatment is the application of a blister to the enlarged glands in the form of the juice of a plant called "Nandera," a Euphorbia found in Busoga and Uganda. The animals are said to recover after this treatment in many cases.

The following table (p. 15) gives the details of the cattle whose blood was examined for parasites.

At Jinja the total number of Bukedi cattle was 210; the blood of 13 of them was examined by films, and the trypanosoma found in 8 = 61·5 per cent. Within one month of the blood examination, 50 out of the 210 had died, probably all from this trypanosoma disease = 24 per cent.

At Kitindis, the total number of Bukedi cattle was 102. The blood of 15 of them was examined by films and the trypanosoma found in

Table I.

No.	Date.	Place.	Animal.	Tryp. in films.	Remarks.
1	10.8.03	Jinja ...	Cow ...	Present, numerous	
2	10.8.03	,, ...	,, ...	,,	Died on Aug. 17. Dog 153 injected on 12.8.03
3	11.8.03	,, ...	Young bull	Absent	Typical case of Mukebi (Grant)
4	11.8.03	,, ...	Bull, dying	Present	*Post-mortem.* Typical
5	11.8.03	,, ...	Bull ...	Absent	Lying down — ? sick
6	11.8.03	,, ...	,, ...	Present	Sick
7	11.8.03	,, ...	,, ...	,, ...	,,
8	11.8.03	,, ...	,, ...	Absent	
9	11.8.03	,, ...	Calf ...	,, ...	,,
10	11.8.03	,, ...	Bull ...	Present	
11	11.8.03	,, ...	,, ...	,,	
12	11.8.03	,, ...	,, ...	,,	
13	11.8.03	,, ...	Calf ...	Absent	
14	12.8.03	Kitindis	Bull ...	Present	
15	12.8.03	,,	,, ...	Absent	
16	12.8.03	,,	,, ...	,,	
17	12.8.03	,,	,, ...	Present	
18	12.8.03	,,	,, ...	Absent	
19	12.8.03	,,	Young bull	Present	Sick. Animal killed. *Post-mortem.* Lymph. glands of neck enlarged and hæmorrhagic; also iliac glands. Heart shows no jelly, but a few small petechiæ under endocardium of L. ventricle. Blood very watery. Spleen slightly enlarged
20	12.8.03	,,	Bull ...	Absent	Typical case of Mukebi
21	12.8.03	,,	,, ...	,,	
22	12.8.03	,,	,, ...	,, ...	Said to have recovered from Mukebi
23	12.8.03	,,	,, ...	,,	
24	12.8.03	,,	,, ...	,,	
25	12.8.03	,,	,, ...	,,	
26	12.8.03	,,	,, ...	,,	
27	12.8.03	,,	,, ...	,,	
28	12.8.03	,,	,, ...	,,	
29	17.8.03	Entebbe	,, ...	,, ...	The after history of these animals is uncertain
30	17.8.03	,,	,, ...	,, ...	
31	17.8.03	,,	,, ...	,, ...	
32	17.8.03	,,	,, ...	Present	Sick. Died on 20.8.03
33	17.8.03	,,	,, ...	Absent ...	After history is uncertain
34	17.8.03	,,	,, ...	,, ...	

3 = 20 per cent. Within one month of the blood examination, six of these had died = 6 per cent.

The animals 29—34 were examined in Entebbe but came from the Bukedi district originally, *viâ* Jinja.

Mr. Grant, the Sub-commissioner of Busoga, considered the herd at

Kitindis to be healthier than that at Jinja, and our examination would seem to bear out this statement. Mr. Grant kept a private herd of about 20 head of cattle at Jinja, and these animals are all healthy up to the present.

On November 12 Mr. Grant wrote to inform us that between September 11 and November 12, 24 more bulls and 7 bull calves had died at Jinja and 4 bulls and 2 bull calves at Kitindis.

Within three months of the blood examination, therefore, 81 out of the 210 Bukedi cattle had died at Jinja = 39 per cent., probably all from the trypanosoma disease. At Kitindis, 12 out of 102 had died within three months = 12 per cent.

We were unable to study the complete course of the disease as it occurred naturally in cattle, so we injected into an ox 10 c.c. blood containing the "Jinja" trypanosoma. The parasite had, however, been passed successively through a monkey (Experiment 135) and a dog (Experiment 164) after being obtained from a sick ox (No. 32 in Table I). The parasite appeared in the peripheral blood films of the ox (162) 12 days after injection.

The details of this experiment down to November 17 are as follows:—

Experiment 162.—Ox.

To note the effect of the subcutaneous injection of blood containing the "Jinja" trypanosoma (T. IV).

September 9, 1903. Injected 10 c.c. blood subcutaneously, from dog (164) containing T. IV.

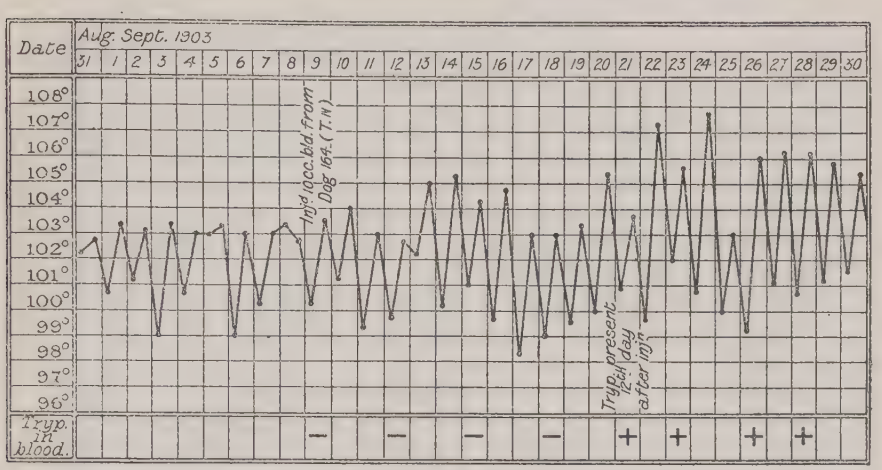
September 21. The ox has been looking thinner and rather seedy from a few days. Trypanosomata were found in blood films to-day—12 days after injection. They are thick and have very blunt posterior extremities. The flagella are very short. In these respects they resemble the original trypanosomata seen in the Jinja cattle (see Plate 1, *c*).

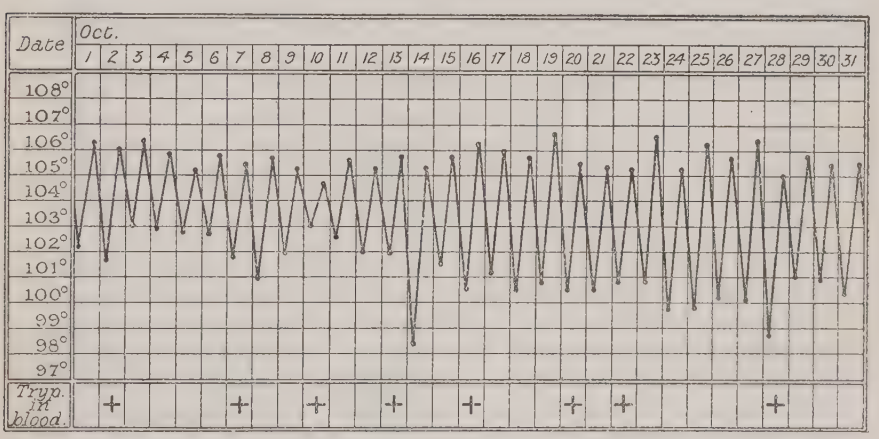
October 8. To-day the ox was noticed to lie down a good deal while out grazing with the other cattle. There is slight opacity of both corneæ.

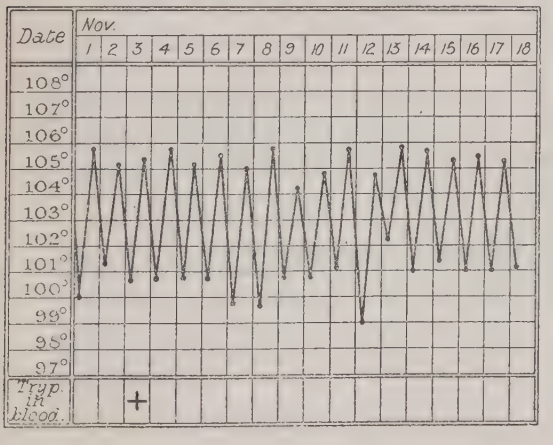
October 28. The animal is in better condition again and does not lie about when grazing. The opacity of the corneæ has not increased. The coat is in good condition.

The following chart (p. 17) gives the temperature curve and the presence or absence of trypanosomata in blood films.

November 17. This animal still shows the trypanosoma in its blood and continues in fairly good condition.


Date
Aug. Sept. 1903
31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97° 96°
Inj.d 100 c.c. bld. from Dog 164. (T.N.)
Tryp. present 12th day after inj.n
Tryp. in blood.
− − − − + + + +


Date
Oct.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97°
Tryp. in blood.
+ + + + + + + + + + + +


Date
Nov.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97°
Tryp. in blood.
+

The "Jinja" Trypanosoma (T. IV). *Its Morphology and Pathogenicity for Animals.*

In the blood of naturally infected cattle, this trypanosoma was often very short and stumpy, with a very short flagellum and a blunt posterior end. This, however, was by no means always the case, as the following details will show. (See Plate 1.)

Case 1.—Trypanosomata very scanty; average length 24 μ, long and slender; flagellum about 8 μ.

Case 2.—Tryp. very numerous and of various sizes. The majority were short and stumpy, about 13 μ long, the flagellum being only 2—3 μ.

Others were 20—25 μ long, the flagellum about 8—10 μ. One very large parasite was seen in this film 44 μ long, with flagellum about 18 μ. It had a very pointed posterior extremity, and single nucleus. The centrosome had just divided. (See Plate 1, *b*.)

Case 3.—Tryp. very numerous. Average length 12 μ; one was only 7·5 μ long.

Case 4.—Tryp. very scanty; average length 22 μ.

Case 5.—Tryp. very scanty; average length 13 μ.

Case 6.—Tryp. numerous; average length 12—13 μ; one seen only 7 μ long.

Case 7.—Tryp. scanty; average length 17—18 μ.

Variations in size and form were also seen in the blood of inoculated animals. In Ox 162, experimentally inoculated from a dog, in Dog 164 and in Goat 192, the trypanosomata were all short and stumpy, with a very short flagellum. In Monkeys 135 and 154, and in the guinea pig (185) the parasites were long and thin and had a pointed posterior extremity; whereas in a sheep (193) on several occasions the trypanosomata were mostly very small, and some showed vacuolation and deformity of shape. This vacuolation and deformity of shape were noted also on one occasion (September 12) in Monkey 135.

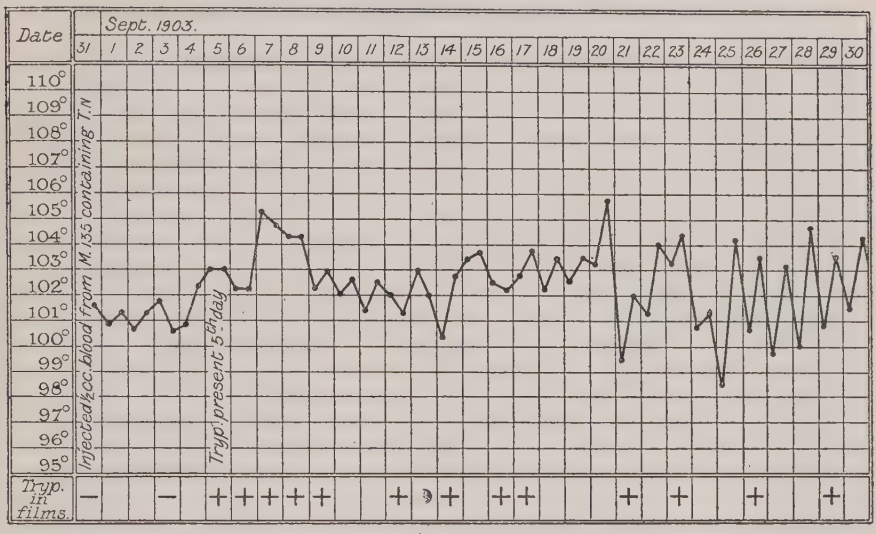
The following were the effects noted after inoculation into animals:—

Ox.—Trypanosomata were seen in films of the peripheral blood 12 days after injection. This experiment is given in detail on p. 16.

Dog.—Trypanosomata appeared in blood films in from 5 to 10 days after inoculation. The animals succumbed in 11 days (two), 26, 29, and 43 days after injection.

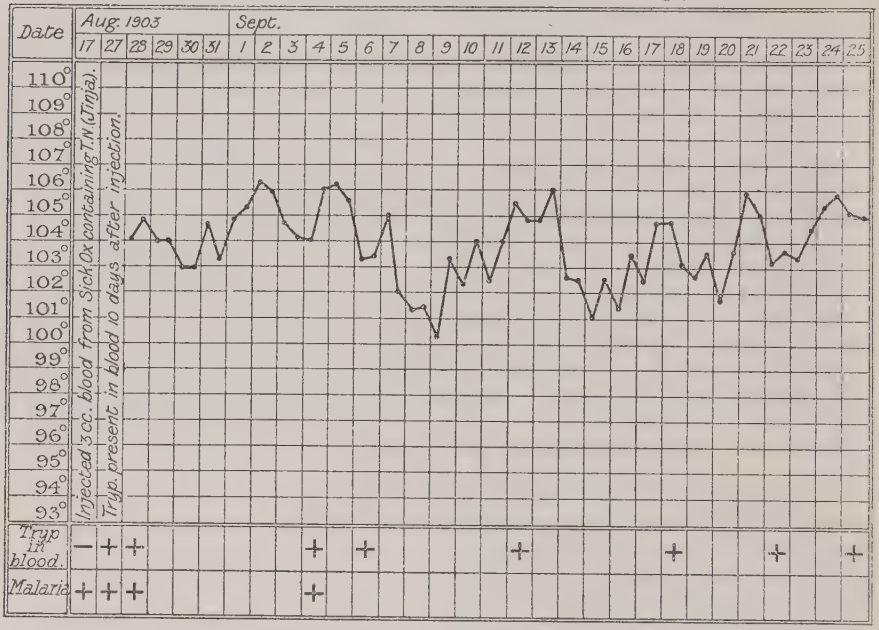
The following chart shows the course of the temperature in a typical case of infection in the dog:—

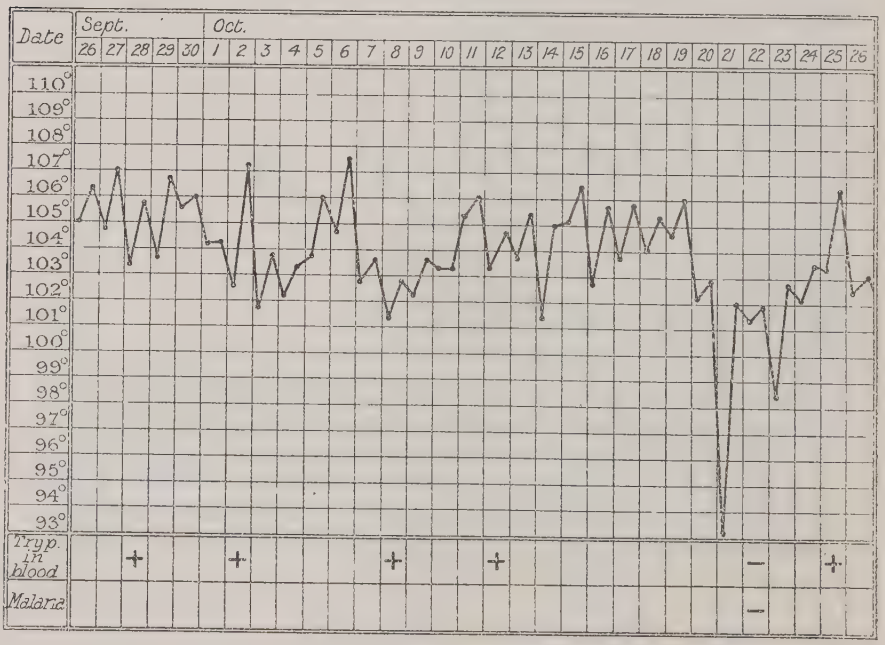
EXPERIMENT 164.—Dog (Native).

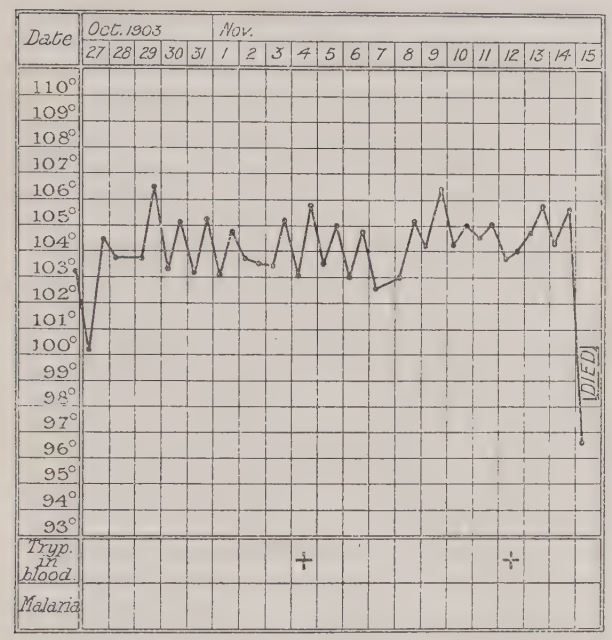

Date
Sept. 1903.
31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
110° 109° 108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97° 96° 95°
Injected ½ cc. blood from M. 135 containing T. N
Tryp. present 5th day
Tryp. in films.
− − − + + +

Monkey.—In two experiments trypanosomata appeared in the blood 10 and 11 days after injection. One animal (135) died on the 39th day

EXPERIMENT 154.—Monkey (*Cercopithecus* sp.).


Date
Aug. 1903
Sept.
17 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
110° 109° 108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97° 96° 95° 94° 93°
Injected 3 cc. blood from Sick Ox containing T.W. (Dutton).
Tryp. present in blood 10 days after injection.
Tryp. in blood.
Malaria





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from traumatic (?) septic peritonitis, the other (154) died 90 days after inoculation. The preceding chart (pp. 20 and 21) shows the temperature curve and the presence or absence of trypanosomata in the blood.

The autopsy was rather interesting, so we append the notes in full.

Post-mortem immediately after death. Body rather thin. No enlarged glands or opacity of corneæ. No increase of pericardial or pleural fluid. The heart showed marked petechiæ all over the surface and jelly-like material round the base. There were signs of endocarditis, and a small ulcer was present on the auricular surface of the mitral valve. Vegetations were present in the left auricle. There were numerous petechiæ under the endocardium of both ventricles.

The lungs showed several small embolic areas.

Peritoneal fluid was not increased. The spleen was distinctly enlarged; on section its substance was firm and dark in colour.

The liver was normal. Both kidneys were studded with small hæmorrhages, on the surface and in the substance. They resembled the embolic areas seen in the lungs. There were no enlarged glands in the abdomen. Smears of the lungs, spleen and kidney showed nothing noteworthy.

In both these monkeys the disease was rather of the chronic variety, and *post-mortem* each showed signs of septic infection. This seems to indicate that in chronic trypanosoma infections, the resisting power of the individual may be so diminished as to render him more susceptible

to bacterial invasion. The terminal infection with streptococci, pneumococci, etc., so commonly seen in Sleeping Sickness, is probably to be similarly explained.

Another monkey (241) showed this trypanosoma in its blood eight days after injection. At the time of writing this Report, the experiment was only just begun, but we are recording it because a hitherto undescribed filaria was discovered in this monkey's blood.* (See Plate 1.)

This was on November 12, 1903, on the day that the trypanosoma was also first seen in films. The filaria embryos had no sheath, a pointed tail, and were about 200 μ long (average of six measured, varying from 189 μ to 218 μ). There was a clear space at the head, and the break in the continuity of the cells, which was well marked, was about 46 μ (limits, 43—50 μ) from the head end.

Guinea Pig.—One guinea pig showed trypanosomata in its blood 29 days after injection. On November 17, 1903, when this Report was written, the animal was still alive and well, and showed parasites in its blood (nine weeks after injection).

Rat (Wild).—Parasites appeared in the blood five days after injection. Death occurred two days later.

Goat (Native).—Trypanosomata appeared in the blood 15 days after injection. During the disease the goat's temperature often rose to 107° F. The parasites were seen in the blood on November 11, 1903, and on November 17 (two months after injection) the animal was still in good condition.

Sheep (Native).—Trypanosomata seen in the blood 18 days after inoculation. In this animal the parasites were never very numerous, and the majority were small, vacuolated and deformed. The sheep's temperature was often 107° F. On November 17, 1903, trypanosomata were present in blood films, and the animal was still in good condition.

(c) *A Trypanosoma occurring in a Dog sent to Entebbe from East Africa (Abyssinian Boundary Commission)* (T. V).

This variety of trypanosoma was obtained from a dog which had accompanied the Abyssinian Boundary Commission. It was stated that the Commission has lost on their journey, from a similar disease, the following animals:—Eleven Boran and Abyssinian ponies as well as several camels and five English dogs. None of their donkeys or mules, which were Abyssinian, suffered from the disease. The breed of this dog was half Airedale and half bull terrier. It was received

* Since this Report was written originally, this experiment has been reported by Dr. Ross, see the 'Journal of Tropical Medicine,' January, 1904. At the time of discovery, Dr. Ross was assisting the Commission and had promised not to utilise any results obtained by us until published by the Royal Society.

on July 13, 1903, by Mr. R. J. Stordy, Principal Veterinary Officer to the Uganda and East Africa Protectorates, to whom we are indebted for the opportunity of studying the disease. On July 20, he noticed that the dog, who previously had been famed for his pluck, became very nervous. One month later, August 20, he found the trypanosoma in the dog's blood, having previously noticed that the corneæ were becoming opaque. On August 23, he despatched the dog to the Commission at Entebbe.

A native (Abyssinian) dog, which was the companion of the English dog and had accompanied it throughout the expedition, remained quite healthy.

From the Boundary the route taken was from Lake Rudolph *viâ* Baringo to Nakuru. The journey from Baringo to Nakuru occupied four days. Two of the ponies above mentioned died of the disease at Nakuru, which indicates that probably the infection occurred at or near the Boundary, and certainly some distance north of Baringo.

EXPERIMENT 160.—Dog (English).

This dog arrived in Entebbe on August 26, 1903, having been sent up from Naivasha, B.E.A., by Mr. Stordy. The animal is rather thin and has opacity of both corneæ, and is consequently blind.

August 27. Many trypanosomata found in the blood (T. V).

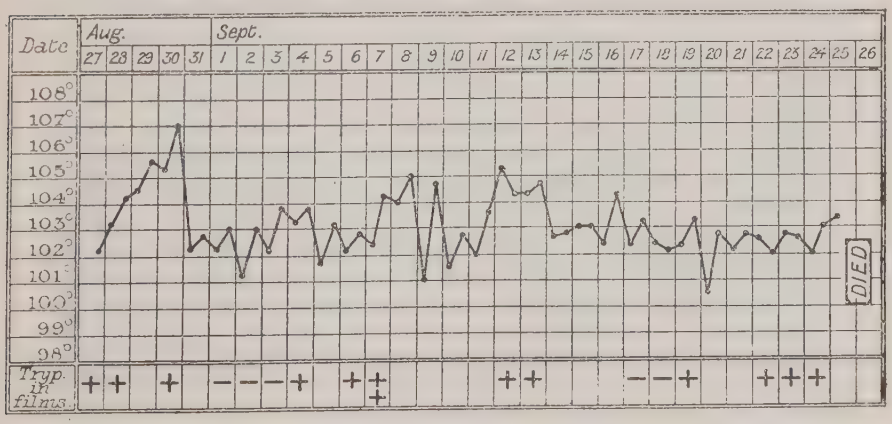
August 28. Many trypanosomata in the blood, which clotted readily. Three c.c. blood injected into Monkey 134.

September 3. During the past few days, since its temperature fell to 102°·4 on August 31, the animal lies about less.

September 7. Dog getting thinner. Blood swarming with trypanosomata.

September 12. Eyes are getting more prominent.

September 25. The dog is now in an emaciated condition, but no swelling of the legs or other part of the body has appeared. He is still able to stand and walk.



September 26. Dog died last evening.

The preceding chart (p. 23) shows the temperature curve and the presence or absence of trypanosomata in the blood from August 27, when the animal arrived in Entebbe.

September 26. *Post-mortem*, 12 hours after death.

Body much emaciated. Both corneæ opaque. No enlargement of superficial glands. No subcutaneous œdema anywhere. On opening the thorax no excess of pleural or pericardial fluid was present. Heart normal; no petechiæ or jelly-like material at the base. Both lungs had small embolic areas under the pleura, otherwise normal.

There was no increase of peritoneal fluid. The spleen was markedly enlarged, measuring 12 inches by $2\frac{1}{2}$ inches broad. On section its substance was soft. The liver and kidneys were normal. There was some enlargement of the mesenteric and retroperitoneal glands.

The "East African" Trypanosoma (T. V). *Its Morphology and Pathogenicity for Animals.*

In the blood of the naturally infected dog (Experiment 160) the parasites were long and slender, measuring in stained films from 20 to 30 μ in length, of which about 6 to 8 μ represented the flagellum. The posterior extremity was usually sharply pointed. On one occasion, when many parasites were present in the dog's blood, several paired forms were seen in which the posterior extremities were fused—the "conjugation" forms of Bradford and Plimmer (see Plate 2, *a*).

In a monkey (*Cercopithecus rufoviridis?*) inoculated from this dog, the parasites were also long and slender, and on several occasions were found swarming in the blood.

Dogs, monkeys, guinea-pigs, rats, a baboon, bull, sheep, goat and donkey were injected with this trypanosoma. The results noted were as follows:—

Dog.—Trypanosomata appeared in the peripheral blood on the third and fifth day after injection. The former dog died 28 days after injection, the latter was alive 10 days after inoculation, when this Report was written. The dog (160), which had contracted the disease naturally, lived at least 72 days after the latest possible date of infection (July 13, when he was received by Mr. Stordy), though how long before this date infection actually occurred we had no means of ascertaining.

Monkey.—Three monkeys were inoculated. One (*Cercopithecus rufoviridis?*) (No. 134) showed parasites in its blood five days after inoculation, and was still alive on November 17, 1903, 81 days after injection.

Another (Cercopithecus, black-faced) died of tuberculosis four days

after inoculation without showing any trypanosomata in its blood, whilst the third monkey (also a black-faced Cercopithecus) showed the parasites in its blood on the third day.

Guinea-Pig.—Two guinea-pigs were inoculated. One died on the 10th day without having shown any parasites in its blood, the other was alive and well 43 days after injection, and showed no trypanosomata in its peripheral circulation.

Rat (Wild).—Two injected rats showed parasites on the third and seventh day, and died on the 10th and 14th day respectively after inoculation.

The *Baboon*, *Sheep*, *Goat*, *Bull* and *Donkey* were all alive and well 43 days after inoculation, and on no occasion could trypanosomata be discovered in films of their blood. We did not, however, inject their blood into rats to see whether it was infectious.

The chief symptom noted in the susceptible animals was irregular fever, the first rise of temperature often coinciding with the appearance of the trypanosomata in the peripheral blood. Sometimes, however, the first appearance of trypanosomata in the peripheral blood was unaccompanied by any rise of temperature. In Monkey 134 the temperature was sometimes as high as 107°·4 F., and was frequently at 106° F.

In some of the animals there was a rapid fall of hæmoglobin and wasting was marked. Œdema, enlargement of lymphatic glands and opacity of corneæ were absent.

Post-mortem, one dog had ecchymoses outside and in the interior of the heart and hæmorrhagic embolic areas in the lungs. Its spleen was enlarged and soft. There was no fluid in any of the serous cavities, nor were the lymphatic glands enlarged.

In two rats the only abnormal appearance *post-mortem* was *slight* enlargement of the spleen.

(d) *A Trypanosoma Occurring in a Sick Mule in Entebbe* (T. VI).

Experiment 179.—Col. Sadler's Mule.

This animal had been in Africa about five years. At first it was in the "fly-belt" of East Africa. It had been in Uganda about 18 months and remained well until it had fever and swelling of the glands in the groin. It was first noticed to be sick on July 3, 1903.

September 9, 1903. Animal brought to the laboratory. Had fever and slight swelling of glands in groin, none elsewhere. Ate well. Was getting thin.

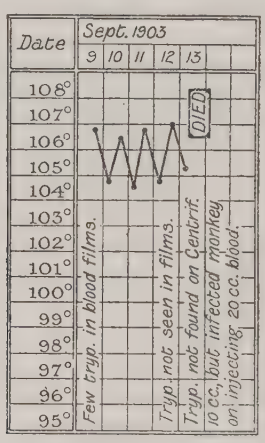
A film of blood was examined and showed a few trypanosomata, very vacuolated in appearance. Eighteen c.c. of blood were injected into Dog 167.

September 12. Blood very pale and watery. *No trypanosomata seen in films.*

September 13. The animal was brought to the laboratory this morning and, on its way, fell down and was unable to rise again. Its breathing was very hurried.

A blood film was examined but *no trypanosoma found.* It died at 11 A.M. and a *post-mortem* was made half an hour after. Blood was obtained from the jugular vein and inoculated into two monkeys (180 and 181) and a guinea-pig. Both monkeys developed trypanosomata in their blood. Ten c.c. of the blood was centrifuged about one and a half hours after death, but no trypanosomata could be found.

The accompanying chart shows the temperature curve and the presence or absence of trypanosoma in the blood :—



September 13. *Post-mortem* half an hour after death.

External appearance—nothing abnormal. No enlarged glands could be felt. No fluid in pericardial or pleural cavities. A few small petechiæ were present on the external surface of the heart and one small one in the interior of the right ventricle. The blood was very watery and the heart muscle pale. No jelly-like material round base of heart. Lungs normal. Spleen enlarged and weighed $4\frac{1}{2}$ lbs. (normal said to be 2 lbs.) ; substance firm. Liver somewhat enlarged, weighing 14 lbs., substance congested. Kidneys normal. There were no enlarged glands in mesentery or retroperitoneum.

Remarks.—The interesting feature of this experiment is the rapidity with which the trypanosomata disappeared from the animal's peripheral blood during the last few days of its life. On September 9 several trypanosomata were seen in a blood film. Three days afterwards they could not be found in blood films, and on the following day they were so scarce that they could not be detected in 10 c.c. of centrifuged

blood taken shortly after death. That they were present, however, is proved by the fact that two of the three animals injected with the blood, obtained *post-mortem*, developed trypanosomiasis.

The "Entebbe Mule" Trypanosoma (T. VI).—*Its Morphology and Pathogenicity for Animals.*

When the mule's blood was first examined, four days before death, only a few trypanosomata were found. These were rather short and very vacuolated. On injection into a dog (167) the parasites which appeared in its blood were long and thin. In another dog (197) which was injected with blood from Monkey 180, the average length of the trypanosoma was about 27 μ, the flagellum measuring 7—10 μ. The edge of the undulating membrane was very distinct and the posterior extremity squarely blunt, resembling a truncated cone. One sexual (?) form seen in a film was 17 μ long (flagellum 6 μ) and in its widest part measured nearly 5 μ across (see Plate 2, *b*). In another dog (226) which was injected from the same monkey (180), but at a later date, the parasites were shorter and broader, sometimes vacuolated and with a short flagellum. In inoculated monkeys similar variations in size and form were observed. In Monkey 180 on several occasions the trypanosomata were normal in appearance, but on other occasions they were crescentic in shape with a broad thick body and very short flagellum. The protoplasm was very vacuolated and in many respects the parasites resembled those seen originally in the blood of the mule. It was noticed that when the parasites showed this peculiar appearance, trypanosomata were, as a rule, scanty in the animal's blood. Blood stained two or three days later contained normal parasites (see Plate 2).

In Monkey 181, the trypanosomata were normal in appearance, thin, about 18 μ long and with a short flagellum. Two days later larger and longer forms were seen (27 μ long) with vacuolation of the protoplasm. As in Dog 197, the posterior end was squarely blunt with the centrosome a long distance from the tip (3—4 μ). Six days later, the trypanosomata were very scanty in the blood and presented the same vacuolation and deformity of shape as Monkey 180. Two days later, many normal parasites were again seen, others still showing vacuolation. On the whole, the parasites seen in the blood of the monkeys were smaller than those in the dog, the flagellum especially being shorter. Dogs, monkeys, rats, a guinea-pig, sheep, goat, ox, donkey, baboon and jackal were inoculated with this trypanosoma, and with the following results:—

Dog.—Trypanosomata appeared in the peripheral blood 4, 5, 8 (twice) and 9 days after injection and the dogs died on the 10th, 14th, 26th, 15th and 10th day respectively. It should be added that the last animal had many ankylostomata in its intestine, which were the immediate cause of death.

Monkey.—Four monkeys were inoculated, two showing parasites on the fourth day and two on the seventh day. Death occurred in 8, 12, 21 and 40 days respectively, but in every case death was due to some other cause than the trypanosoma infection.

Rat (*Wild*).—Trypanosomata appeared in the blood on the third and fifth day. The former animal died in 22 days, the latter was still alive $7\frac{1}{2}$ weeks after the inoculation, when this Report was written. This trypanosoma appears to be less virulent for rats than either the "Jinja" or the "East African" parasite.

Jackal.—The infected jackal was an interesting experiment. On July 24, 1903, it was injected with blood containing human trypanosomata from Karala Barigi. The parasite appeared in its blood on August 4 and continued present, with intervals of absence, until September 22, after which date human trypanosomata were no longer seen in films. On the night of November 1, the jackal killed and devoured almost entirely a monkey which had many "mule" trypanosomata in its blood. On November 3, about 36 *hours* after its feed, the blood was found to contain very many trypanosomata. On November 5 the jackal looked seedy and lay about a great deal. There was a semi-purulent discharge from the eyes. Trypanosomata continued present in the blood and on November 17 were swarming. The jackal died on that date, about 15 days after it ate the monkey.

Three interesting points are brought out in this experiment. First it shows that the jackal resembles the dog in its behaviour to the human trypanosoma, inasmuch as the parasite multiplies to a certain extent in the blood but eventually disappears or becomes so scanty as not to be detectable in blood films. Secondly, that the animal was susceptible to infection with another trypanosoma which proved fatal, showing that the human and mule trypanosomata are different. Thirdly it shows that infection can be conveyed *vid* the alimentary tract, though possibly not through the stomach but through abrasions of the mouth or other soft parts, produced, in this case, by the bones of the monkey whilst being eaten or swallowed.

The inoculated guinea-pig, sheep, goat, ox, donkey and baboon were all alive and well on November 20, 1903, 69, 53, 53, 53, 38 and 38 days respectively after inoculation. The animals were all reinjected with blood from the jackal, containing many trypanosomata, on November 8 and 9, but on no occasion could the parasite be found in blood films. Nevertheless they all suffered from occasional rises of temperature, sometimes as much as 105° or 106° being recorded, and the ox got distinctly thinner. We injected some blood from this ox (202) into a dog (239) and although the ox never showed trypanosomata in blood films, its blood was infectious, for the dog had parasites in *its* blood eight days after the injection and died a week later. We did not test the blood of the other animals, but had we done so, in all probability

we should have found that it was infectious, seeing that all the animals had irregular rises of temperature.

Of the susceptible animals, the dogs and monkeys had fever and the latter, in addition, showed diminution of hæmoglobin and wasting. Œdema, enlargement of superficial glands and opacity of corneæ were absent. In the dogs, the disease was rather acute and none of them showed much wasting.

Post-mortem.—The spleen was enlarged in all the animals, especially in the dogs. The liver and kidneys were often pale and fatty-looking. The heart rarely showed petechiæ and only occasionally was there any free fluid in the serous cavities. Two of the dogs had embolic areas in the lungs. In the rat, the abdominal and retroperitoneal glands were considerably enlarged; none of the other animals had any notable enlargement of the lymphatic glands. The rat's spleen was enlarged, and smears showed, in addition to many normal trypanosomata, vacuolated and "amœboid" forms.

Section II.—Continuation of the Observations on Five Cases of Trypanosomiasis in Man, and of the Earlier Experiments on Monkeys and other Animals, Including Some Observations on Piroplasmosis in Dogs.

Of the five cases of Trypanosomiasis originally under the observation of the Commission, four were apparently in good health at the time of writing this Report, the fifth (Bara Risgallah) on one occasion was found asleep when at duty. We failed to find trypanosomata in the cerebro-spinal fluid of any of the patients, even in the case of J. Murjan and Karala Barigi, both of whom had shown them on two occasions previously. On centrifuging 10 c.c. of blood from these five patients, only two of them (Murjan and Barigi) showed trypanosomata in November, 1903.

Of the earlier experiments, we are furnishing records only of those which are completed or which have a special interest. The details of these experiments prior to August 27 will be found in Nos. I and IV of the Reports of the Sleeping Sickness Commission already published.

Monkeys 34 and 95, which have been injected with cerebro-spinal fluid containing trypanosomata, have died. The details are as follows:—

Experiment 34.—Monkey (*Macacus rhesus*).

Injected with C. sp. fluid (containing T. I) in vertebral canal on April 8, 1903.

Last note by Colonel Bruce was on August 25.

September 7. During the past 10 days, this monkey has been lying

about much and often sitting with his head bent down on his chest. Yesterday he was much as usual, but got rapidly worse, and was obviously dying this morning. His temperature was 94°·4.

Post-mortem immediately after death.

Body thin. Coat very rough and staring. Heart normal. In the lungs there were a few pigmented areas looking like old tubercles. The liver was fatty. Spleen normal. Kidneys pale. The inguinal, mesenteric and retro-peritoneal glands were enlarged, also those in the left axilla.

Brain.—No very marked signs of disease. Not much flattening of the convolutions. Slight adhesions at the base of the brain. There was a little opacity of the sulci.

Some fluid from the third ventricle was examined, and a few living and active trypanosomata were seen. The film contained much blood, and the trypanosomata may have come from the blood.

Films of heart blood stained, showed very few trypanosomata, but no "involution" forms.

The brain was fixed and hardened and sent home to Dr. Mott. We have since heard that no minute pathological changes were present in the brain of this monkey.

Experiment 95.—Monkey (*Cercopithecus* sp.).

Injected intraspinally with C. sp. fluid (containing T. I) on May 14, 1903. Tryp. in blood films on June 4.

August 26. About 8.30 A.M. monkey had a convulsive seizure affecting the left side of the body. It lay on the ground for about an hour suffering from paresis. This gradually passed off. Monkey appears rather bent up.

August 27. Evening temperature, 101°·6.

August 28. Monkey getting gradually weaker. No definite symptoms of Sleeping Sickness.

Blood examined. Animal very anæmic; blood obtained with great difficulty, and is extremely pale. *Tryp. abs.* Mal. absent. Many nucleated red corps. Temperature: morning, 100°; evening, 100°·8.

August 29. Animal was found dead this norning.

Post-mortem, Brain.—Convolutions a little flattened; not congested, and no ground-glass appearance as in Sleeping Sickness.

Heart.—No jelly-like material externally. No petechiæ.

Lungs.—Both showed embolic areas.

Spleen.—Congested and slightly enlarged.

Kidneys and Liver pale.

A drop of C. sp. fluid from lateral ventricle examined, but no living trypanosomata seen. Possibly the animal had been dead too long.

Heart blood film:—No tryp. seen in stained preparation.

"Fresh-fly" Feeding Experiments.

The two "fresh-fly" feeding experiments next recorded are of considerable interest.

Experiment 136.—Monkey (*Cercopithecus* sp.). Small.

This animal was kept as a "control" from July 23 until August 28, 1903. It was then used to feed fresh tsetse flies upon. Between August 29 and October 4, 723 flies fed on this monkey.

October 6. During the past few days, this monkey has been looking seedy, sitting crouched up with its back bent and head thrown forward on its chest, much like the attitude adopted by the sick monkeys, 1, 60 and 34 before they died. He has been getting very thin, evidently the drain of blood, by so many flies feeding on it, has been too great. Died at 3 P.M. to-day.

Post-mortem.—All organs were very pale and bloodless. Film of heart blood was typical of profound anæmia—red corpuscles of all sizes, many nucleated and showing polychromatophilia.

No trypanosomata seen.

Remarks.—Although 723 "fresh" flies fed on this monkey, trypanosomata were never found in its blood. The original experiment (No. 94, in earlier Reports) had only 225 flies fed on it, when the tryp. appeared in its blood. The flies were brought sometimes from the Botanical Gardens, and at other times from the shore of the lake near the hut-tax labourers' camps, as they had always been. It is significant that over 700 flies failed to convey the tryp. to this monkey—although it was small, about the same size as Monkey 94. The only obvious difference between this experiment and Experiment 94 (as recorded in No. I of the Sleeping Sickness Commission Reports) is that during the progress of this experiment, practically no hut-tax labourers came into Entebbe, and those that did come were housed away from the fly-area.

Experiment 228.—Monkey (*Cercopithecus* sp.).

Between October 12 and November 12, 1903, no less than 757 freshly caught tsetse flies were fed on this monkey without causing the appearance of trypanosomata in its blood. The same remarks as to hut-tax labourers apply to this experiment as to Experiment 136.

(1) *Re-Injection Experiments.*

In order to ascertain whether "refractory" animals could be made more susceptible and show the trypanosoma in the peripheral blood, we re-injected them with trypanosoma-containing blood or cerebro-spinal fluid, sometimes on as many as three occasions at

intervals of a week or a fortnight, and in every case with a negative result.

The details, in tabular form, are as follows :—

Blood Trypanosoma.

Guinea-pig 81	Re-injected	once.
Goat 90	,,	once.
Donkey 101	,,	twice.
Ox 148	,,	twice.
Sheep 149	,,	once.
Pup 146	,,	once.

Cerebro-Spinal Fluid Trypanosoma.

Guinea-pig 82	Re-injected	once.
Sheep 89	,,	four times.
Donkey 100	,,	three times.
Ox 132	,,	three times.
Pup 144	,,	three times.

Guinea-pig 82 became pregnant after the second injection, and bore a healthy young one which thrived.

The pups 144 and 146 both developed the *Piroplasma Canis* in their blood, to which infection they succumbed. These experiments are given more in detail later. An interesting fact is that the blood of Pup 144, although it never showed the trypanosoma in films, was nevertheless infectious, because a monkey inoculated with it developed trypanosomata as well as piroplasmata in its blood.

We also inoculated a cat with 10 c.c. blood containing the human trypanosoma, but eight weeks after the inoculation the cat's blood did not show any parasites in films.

(2) *Re-inoculation and Cross-inoculation Experiments with the Human Blood and Cerebro-spinal Trypanosomata.*

Several of the earlier experimental monkeys having failed to show trypanosomata in blood films at many of the weekly routine examinations of their blood (the parasites having previously been easily found in them), it occurred to us that possibly a condition of immunity had been established. We therefore re-injected five of these monkeys, Nos. 32, 61 and 123 with blood, and Nos. 54 and 96 with cerebro-spinal fluid containing trypanosomata. In one case the parasite did not reappear in the peripheral circulation as long as six weeks after this re-injection. In the other cases, sufficient time had not elapsed when this Report was written, to be certain that the trypanosomata would not reappear, though in none of the cases had they done so. These observa-

tions seem to indicate that the monkeys in question had become immunised against the trypanosoma injected. The next step, should the first trypanosoma have failed to reappear, would be to inoculate Monkeys 54 and 96 with the blood trypanosoma, and Monkeys 32, 61 and 123 with the cerebro-spinal trypanosoma. It was arranged that one of us (E. D. W. G.) should continue these experiments on those lines, because if the immunised monkeys failed to respond to injections of the other trypanosoma, this would be in favour of the identity of the *Trypanosoma Gambiense* and the *Trypanosoma Ugandense.*

The two cases next reported are Sleeping Sickness in a Persian, this being the first instance of the disease in an Asiatic; a case of "recurrent fever," associated with the presence of spirochætes in the blood, sent up as a case of Sleeping Sickness.

(3) *Case* 248. *Sleeping Sickness in a Persian. Name, Suleman Bin Mohamed. Age about* 45 *years. Came originally from Bushire, on Persian Gulf.*

October 28.—*History.* Has been in Africa 20 years, of which he spent the first two years in East Africa. Has been in Uganda on and off for 18 years, and has been down to the Coast twice in that time. Latterly he has been a "headman" in the Government Transport Department, and when in Entebbe has lived near the lake. In fact, for some time he has lived almost like the natives and with them. He became ill two months ago, and was then seen by Dr. Hodges, whose report is as follows:—

September 2. There are general tremors, anæmia, slight pyrexia. Temperature, 100° F. Weak, irregular, rapid pulse. Spleen slightly enlarged. Left otitis media. Blood films examined. Malaria found.

October 28. *Lumbar puncture performed.* Tryp. numerous; one seen in first field. Many lymphocytes. No R.B.C.

October 31.—*Present state.* Patient is a very tall man, obviously wasted and ill. There is a heavy, sad look about the face and eyes. General condition very weak and feeble. Gait weak and staggering. Voice weak. Marked tremor of tongue and lips. Slight tremors of fingers and hands. There is a fairly marked general tremor of the body and head. No enlarged glands about neck, slight in groin (due to sore feet). Has pain in left ear, due to otitis media. Pulse, fair tension, 68 per minute. K.J. sluggish. Heart sounds feeble; no bruit.

November 6. Photograph taken by Mr. R. J. Stordy.

November 12. Patient has improved to a certain extent since he has been in hospital.

(4) *Bafirawala. Æt.* 12 *years. Recurrent (Spirochœte) Fever.*

This patient was admitted to hospital on August 12, 1903, as a case of Sleeping Sickness. He never showed any definite signs of

Sleeping Sickness, but was suffering from "Spirochæte"—(? Relapsing) —Fever; and as this appears to be the first case occurring in Uganda which has been studied, we thought it advisable to put it on record.

August 18. During the past four days the temperature has risen gradually until it reached a maximum of 104°·8 last evening. This morning it fell to 103°·4. Patient complains of pain in both knee joints, but has no pain elsewhere. Pulse is rapid, but regular in force and rhythm. There is a slight systolic apical murmur. The spleen is considerably enlarged, and can be felt two fingers' breadth below the costal margin.

Blood films were examined, and some spirochætes were seen; also filariæ. No trypanosoma or malaria. A fresh drop of blood was examined later, but no motile parasites were seen.

At 6 P.M. the temperature rose to 106°·2 F.

August 19. This morning the temperature has fallen to 99°·4, and patient is more comfortable. The spleen is smaller than it was yesterday. Tr. opii is being applied to the swollen, painful knee joints.

August 20. Patient's general condition is better than yesterday, but the pain in the knees continues.

August 23. Temperature rose again yesterday to 102°·4, and this morning is 103°·8. The spleen is easily palpable, but no larger than yesterday. Blood examined; no spirochætes, but one doubtful malarial parasite seen. Temperature at 3 P.M. was 99°. Blood again examined; no spirochætes or malaria seen.

August 26. Temperature rose again last night to 104°·4, and this morning has fallen to 101°·2. Blood examined: few spirochætes seen.

September 14. Since last note patient has had slight fever, with occasional rises to 101°.

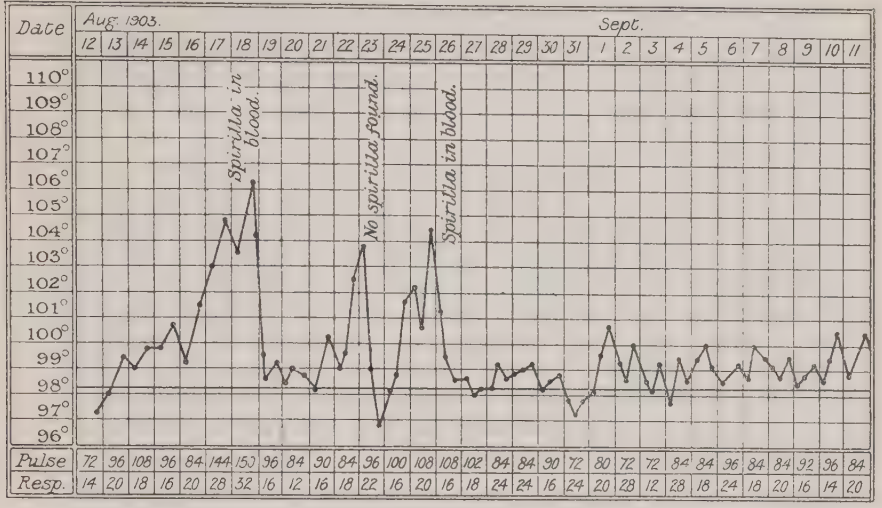
To-day *lumbar puncture* was performed, but no fluid could be obtained, indicating that there was probably no increased pressure in the spinal canal.

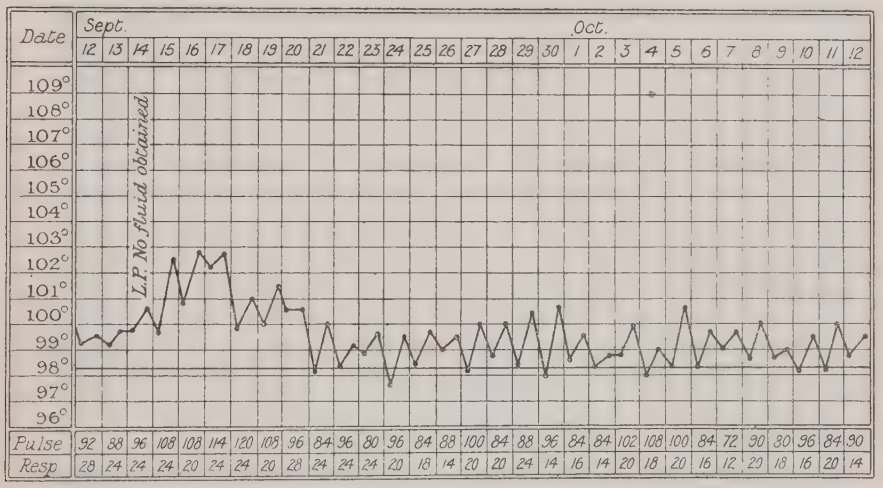
Patient has headache, and his speech is weak and indistinct. No tremor of the tongue or fingers. The gait is rather weak, but probably this is on account of the swelling and pain in the knees.

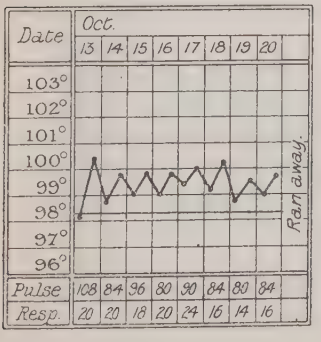
October 20. The temperature was raised for a few days after the lumbar puncture, and there has been slight pyrexia since last note.

Patient's general condition is improved. He ran away from hospital to-day.

The following chart shows the temperature curve, the pulse and respiration rate, and the presence or absence of spirochætes in the blood:—


Date
Aug. 1903.
Sept.
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11
110° 109° 108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97° 96°
Spirilla in blood.
No spirilla found.
Spirilla in blood.
Pulse 72 96 108 96 84 144 150 96 84 90 84 96 100 108 108 102 84 84 90 72 80 72 72 84 84 96 84 84 92 96 84
Resp. 14 20 18 16 20 28 32 16 12 16 18 22 16 20 16 18 24 24 16 24 20 28 12 28 18 24 18 20 16 14 20


Date
Sept.
Oct.
12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12
109° 108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97° 96°
L.P. No fluid obtained.
Pulse 92 88 96 108 108 114 120 108 96 84 96 80 96 84 88 100 84 88 96 84 84 102 108 100 84 72 90 90 96 84 90
Resp 28 24 24 24 20 24 24 20 28 24 24 24 20 18 14 20 20 24 14 16 14 20 18 20 16 12 20 18 16 20 14


Date
Oct.
13 14 15 16 17 18 19 20
103° 102° 101° 100° 99° 98° 97° 96°
Ran away.
Pulse 108 84 96 80 90 84 80 84
Resp. 20 20 18 20 24 16 14 16

Since writing the above, Dr. Hodges has had several cases of a similar kind in Entebbe, occurring in an Indian and in native Waganda. In all his cases the spirochætes were very scanty in the blood and were seen only in stained films, not in a fresh specimen.

(5) *Piroplasmosis in Two Experimental Dogs.*

As mentioned previously in this section, two pups (144 and 146) received respectively four and two injections of human trypanosomata without showing the parasites in blood films. A week or two after the last injection both animals were seedy, and on examining their blood an infection with the *Piroplasma canis* was discovered. The puppies had the run of the laboratory compound, and occasionally strayed beyond its precincts, so that they may have become infected outside, especially as two other fatal cases occurring in Entebbe were brought to our notice about the same time.

A monkey (213) and a dog (214) were injected with blood from Pup 144. Both monkey and dog showed piroplasmata in blood films on the 11th day, the monkey also showing trypanosomata on the 15th day, although the pup itself had never shown trypanosomata in films, even after four injections of cerebro-spinal fluid. The injected monkey was still alive when this Report was written; the dog developed irregular fever, suffered rapid diminution of hæmoglobin, and had albuminuria. It died five and a-half weeks after inoculation with the piroplasma, and *post-mortem* the liver, spleen and kidneys were enlarged and congested. The details of the experiments are as follows:—

Experiment 144.—Pup (Brindled). Injected with C.-sp. Fluid containing Trypanosomata (T. I).

This dog was reinjected with C.-sp. fluid on September 1 (4 c.c.), on September 7 (4 c.c.), and on September 14 (8 c.c.).

September 15, 1903. Tryp. absent from blood films.

September 22. Tryp. absent from blood films.

September 29. Tryp. absent. *Piroplasma canis* present in large numbers. No symptoms except rise of temperature (105°·8). Urine normal in appearance.

October 1. Blood very pale to-day. Animal worse. Piroplasmata numerous. At 4 p.m. she passed a little urine, markedly coloured by hæmoglobin. Much albumen present. Some blood was taken and injected into Monkey 213 and Dog 214. The monkey developed the *piroplasma in its blood on the 11th day* and *trypanosoma 15 days after injection.* The dog (214) became infected with the piroplasma and died about five weeks later.

October 2. Animal died during the night.

Post-mortem.—Body fairly well nourished. No enlarged superficial

glands. No increase of pericardial or pleural fluid. Heart normal. Lungs showed minute embolic areas. Liver somewhat enlarged and rather fatty. Spleen enlarged, measuring 7 inches by 2 inches. Kidneys were markedly congested, especially the cortex and the surface. The hilum was red in colour as though stained with hæmoglobin. Bladder contained reddish brown (dark sherry-coloured) urine. No increase of peritoneal fluid.

Remarks.—This puppy harboured the trypanosoma, although it failed to show them in blood films. On injecting the puppy's blood into a monkey, the trypanosoma appeared in 15 days in the peripheral blood.

EXPERIMENT 146.—Puppy. Injected with Human Native Blood, containing Trypanosomata (T. II).

September 21, 1903. Reinjected 5 c.c. blood from J. Murjan containing trypanosomata.

September 22. Tryp. absent.

September 29. Tryp. absent. *Piroplasma canis* present (fewer than in Dog 144). Blood pale and watery, but dog seems in good condition. Some fever. Urine normal.

October 13. The dog is somewhat out of condition, but no dark urine has been observed, and he takes his food fairly well.

November 3. The temperature rose on October 27 to 106°, and since then has been fluctuating between 103° and 104°·6. The animal has been lying about again for the last few days. During the night he passed some "smoky" urine, containing albumen. Dog looks very thin and seedy to-day. Piroplasma present in the blood.

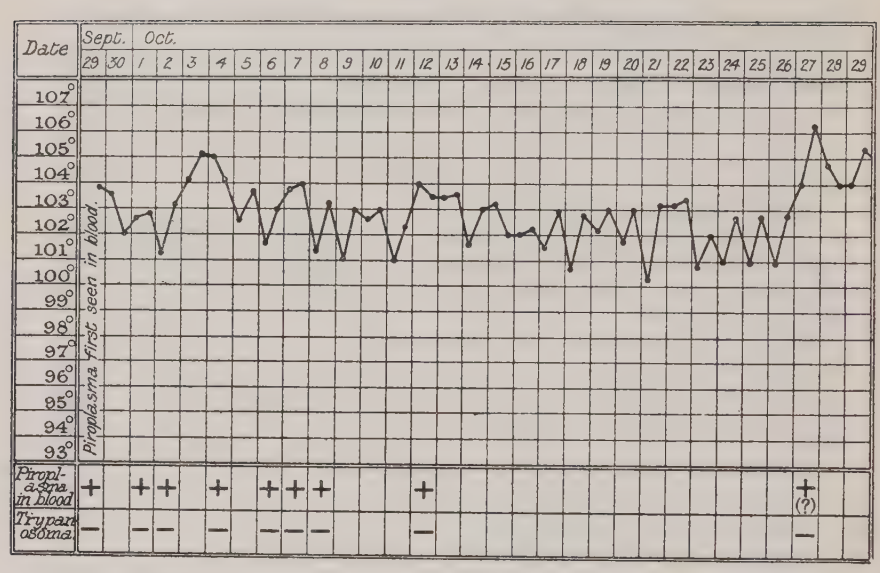
November 5. Animal died to-day at 2 P.M.

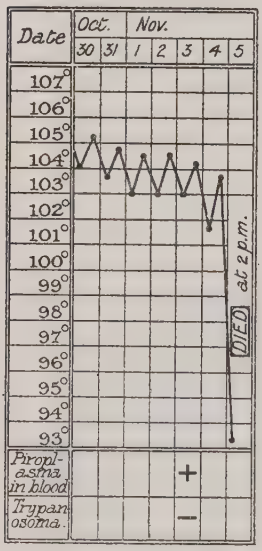
The following chart (p. 38) shows the temperature curve and the presence or absence of trypanosoma and piroplasma in the blood.

November 5. *Post-mortem.*—Soon after death. Body fairly well nourished. No enlarged glands. Heart normal. Both lungs show well-marked embolic areas. Spleen enlarged, measuring 10 inches by $2\frac{1}{2}$ inches. Liver congested. Kidneys look normal—capsule strips readily. The bladder contains some urine containing blood and albumen.

Smear of Lung Emboli.—Many red corpuscles infected with piroplasma, many more than were found in the peripheral circulation.

Smear of Spleen.—Some infected corpuscles present.





Section III.—Is there a Specific Carrier for Each Variety of Trypanosoma?

In the "Appendix to the Further Report on the Tsetse Fly Disease in Zululand," Colonel Bruce states that he examined the proboscis and stomach contents of the tsetse flies at varying intervals after feeding on an infected animal. The proboscis showed one or two

active trypanosomata up to 46 hours after feeding. The stomach, on the other hand, in some cases contained blood up to 118 hours after feeding, and in rare instances numerous and vigorously active trypanosomata were seen amongst the unchanged red blood corpuscles.

In our earlier experiments with the East African trypanosoma (T. V) in *Glossina palpalis*, we found that the trypanosomata very rapidly lost their motility in the flies' stomachs—sometimes in as short a time as three hours.

The "Jinja" trypanosoma (T. IV), on the other hand, was found actively motile in the stomach contents of *Glossina palpalis* after a considerably longer interval, up to 100 hours.

These observations naturally suggested the question "Is there a specific carrier for each variety of trypanosoma?"

In attempting to answer this question the following experiments were carried out:—

(1) *Glossina palpalis* was fed on animals infected with trypanosomata (T. IV, V and VI) and, after intervals of 6 and 24 hours, on healthy animals.

(2) Stomoxys were similarly fed on infected and afterwards on healthy animals. Tabanidæ were also tried, but it was found that they would not feed on dogs, monkeys or oxen when in captivity in feeding-boxes.

(3) *Glossina palpalis* and Stomoxys were fed on animals infected with trypanosomata (T. I, IV, V and VI) and dissected after varying intervals, in order to ascertain whether there was any striking difference in the length of time that the trypanosomata remained alive in the stomach contents.

The dissection experiments with the human trypanosoma are difficult, because one rarely finds many trypanosomata in an infected monkey, and consequently the stomach contents of flies contain comparatively few parasites.

The experiments conducted in East Africa (*vide* Section IV) show that one or more of the varieties of Glossinæ found there are capable of conveying the trypanosoma of Sleeping Sickness.

(1) *Can the* Glossina Palpalis *Carry other Trypanosomata than the Human?*

The *Glossina palpalis* was fed on animals infected with the Jinga (T. IV), East African (T. V), and Entebbe mule (T. VI) trypanosomata, and, after intervals of 6 and 24 hours, on healthy monkeys. *Two of these experiments were positive.* The *Glossina palpalis* conveyed the "Jinja" trypanosoma six hours, and the "mule" trypanosoma 24 hours, after feeding on an infected animal. Negative results have so far been obtained in the case of T. V, the "East African" trypanosoma.

We would add that in order to eliminate as far as possible the chances of the "fresh" flies harbouring trypanosomata, the freshly caught flies were kept for 18 to 24 hours, then fed on a "clean" monkey, and then kept for another 24 hours before being used for the feeding experiments.

It was noticed in these feeding experiments (both with human and animal trypanosomata) that when monkeys became infected in this way, the parasites were never plentiful in the peripheral blood, even many weeks after infection occurred. The temperature, also, of monkeys infected by feeding did not show the same elevations as in the case of monkeys which developed trypanosomiasis after injection.

(2) *Can other Biting Flies Convey Trypanosomata?*

Stomoxys and Tabanidæ were used in the attempts to answer this question. Stomoxys were easily procurable in Entebbe, especially where many dogs and cattle were herded. Mr. E. E. Austen informs us that there were at least two species of Stomoxys amongst those used in our experiments. Feeding experiments were carried out with all three animal trypanosomata (T. IV, V and VI), and *in no case*, so far, have we succeeded in conveying the parasites from infected to healthy animals by feeding Stomoxys on them after intervals of 6 or 24 hours.

Tabanidæ were less easy to obtain, and, moreover, were found useless for these feeding experiments, as they refused to bite dogs, monkeys or cattle when in captivity in the feeding-boxes.

(3) *Dissections of Flies* (Glossina *and* Stomoxys) *after Feeding on Animals Infected with Trypanosomata.*

The results of these experiments are best seen in tabulated form as follows:—

Table II.—*Glossina palpalis.*

Species of trypanosoma.	Longest time since feeding that active tryp. were seen in stomach contents.	Remarks.
	hours.	
Sleeping Sickness (T. I)...	71	Fairly actively motile
Jinja disease (T. IV)	100	Actively motile
East African (T. V)	5½	Movements very sluggish 3½ hrs. after feeding. Ceased after 5½ hrs.
Mule (T. VI)	20	Only sluggishly motile at this time. Many inactive ones seen 21 hrs. after feeding

Table III.—Stomoxys.

Species of trypanosoma.	Longest time since feeding that active tryp. were seen in stomach contents.	Remarks.
	hours.	
Jinja disease (T. IV)	24	Tryp. sluggishly active. Many active filaria embryoes seen*
East African (T. V)	12	Some fairly active. Many inactive seen 21 and 27 hrs. after feeding
Mule (T. VI)	30	Some inactive tryp. seen 43 hrs. after feeding

* The monkey (241) on which these flies were fed had many embryo filariæ in its blood (see p. 22).

Several interesting points are brought out in these dissection experiments. First, the great variation in the times after feeding that active trypanosomata were seen in the stomach contents of *Glossina palpalis*, namely, $5\frac{1}{2}$, 20, 71 and 100 hours. It explains the failure to convey the "East African" trypanosoma by feeding flies on infected animals, and 6 or 24 hours later on healthy animals as recorded on p. 39. It is curious that in the case of the "mule" trypanosoma, the fly-feeding experiment was positive after a 24-hour interval, although on dissection we did not find active trypanosomata in the flies' stomachs longer than 20 hours after a feed.

Secondly, in Stomoxys, the intervals after feeding, during which active trypanosomata were present in the stomach were more nearly the same in the case of the three animal trypanosomata (T. IV, V and VI), but it is noteworthy that the East African and mule parasites were found active for a longer period in Stomoxys than in *Glossina palpalis*.

Thirdly, in the earlier dissections *cold* physiological saline solution was added to the (often very viscid) stomach contents in order to get satisfactory fresh films. Later, we always diluted the stomach contents with *warm* saline, as it was found that by so doing the trypanosomata were active for longer periods after feeding; and all the times recorded in the above tables were got by that method.

The proboscis of the flies was also examined in many cases, but active trypanosomata were only occasionally found in Glossinæ, namely, $3\frac{3}{4}$ hours in the case of T. IV (Jinja), and $2\frac{1}{2}$ hours in the case of T. V and T. VI (East African and mule). Although the proboscis was frequently examined at later periods, trypanosomata were never seen.

In the Stomoxys, the proboscis is darker and more opaque than in the Glossinæ, so that it is very difficult to see red blood corpuscles or trypanosomata in it. We therefore soon gave up looking for trypanosomata in the proboscis of Stomoxys.

These experiments were not quite completed when this Report was written, so that the times recorded above may have to be slightly altered as the result of further dissections.

In order to ascertain whether any developmental changes occur in the flies' stomachs analogous to those which are found in the case of the malarial parasite in the stomach of Anopheles, specimens of the stomach contents were stained (by Leishman's method) at varying periods after a feed. We may state at the outset that hitherto we have obtained no undoubted evidence of any such change.

In the case of the "Jinja" trypanosoma, Glossinæ were dissected and the stomach blood stained 42, 71 and 100 hours after a feed. In the first film (42 hours) the trypanosomata were normal in form and size, the protoplasm of the body vacuolated and staining fairly well, whereas the undulating membrane and flagellum were unstained. The nucleus and centrosome were stained red, and the latter was usually further from the posterior extremity than is normally the case.

In the film stained 71 hours after a feed, the trypanosomata were very numerous. This was noticed also in the fresh film which was examined at the same time. The parasites were all very long, and all stained badly. The protoplasm of the body was pink instead of blue; the undulating membrane and flagellum were unstained, as was also the nucleus in most cases. The centrosome, on the other hand, was deeply stained.

No trypanosomata could be seen in the stained specimen made 100 hours after a feed, though in the fresh film active trypanosomata were present.

In the case of the "East African" trypanosoma, the stomach contents of Glossinæ were stained $3\frac{1}{2}$, $6\frac{1}{2}$, 23, 24, $26\frac{1}{2}$ and 28 hours after a feed.

In the first film ($3\frac{1}{2}$ hours) the trypanosomata were fairly numerous, and showed the same changes as those described above as occurring in the later stages of the flies fed on the "Jinja" trypanosoma. The protoplasm was swollen up and vacuolated. The membrane and flagellum were unstained. The nucleus and centrosome stained well and seemed more distant from one another than usual.

In the specimens stained subsequently, these degenerative (?) changes became more marked, the protoplasm especially being more vacuolated and staining hardly at all.

In the case of the "mule" trypanosoma, more extended observations were made, and the stomach contents of Stomoxys, as well as of Glossinæ, were stained and examined. In the stomach of Glossinæ,

trypanosomata of normal shape and size were seen as long as 26 and 32 hours after a feed, the nucleus and centrosome being well stained, but the protoplasm very pale. Many of the films showed curiously shaped parasites, also amœboid forms and plasmoidal masses, many vacuolated trypanosomata and some with the nucleus dividing up into smaller "chromatin" fragments. (See Plate 3.)

The stained stomach contents of Stomoxys showed trypanosomata fairly normal in appearance up to 17½ hours after a feed. In addition to these, vacuolated and deformed parasites were also seen as in the case of Glossinæ, but amœboid and plasmoidal forms were only exceptionally met with.

In a film from Stomoxys, stained 43 hours after a feed, no trypanosomata were seen, though in the fresh film made at the same time some inactive ones were present.

(4) *Conclusions to be Drawn from the Foregoing Experiments and Observations.*

Our experiments as recorded in this Report are not sufficiently numerous and, in many cases, not sufficiently far advanced to enable us to pronounce definitively upon the nature of the four animal trypanosomata we have encountered during our researches. Certain conclusions would, however, appear to be permissible.

The disease, known locally as "Mukebi," among the transport oxen in Entebbe, associated with the presence in the peripheral blood, in the earlier stages of the disease, of the trypanosoma we have called T. III, appears to be distinct from Nagana and Surra. The trypanosoma was found to be non-pathogenic for a dog which was injected on two occasions with large numbers of the parasite. Another dog and a monkey injected with blood taken *post-mortem* from the ox, also failed to develop a trypanosomiasis, but these two latter experiments are not conclusive as demonstrating that the monkey and dog injected were insusceptible to this trypanosoma, because we failed to find the parasite on several occasions when the ox blood was examined by centrifuge during the last six weeks of the animal's life.

Further experiments are necessary to see whether this trypanosoma is pathogenic for monkeys especially, but also for other animals, for it is quite possible that the disease "Mukebi" is allied to Sleeping Sickness in man, and that the trypanosomata are identical. We endeavoured to get a fresh strain of this animal trypanosoma and, with that end in view, examined the blood of several others of the transport oxen in Entebbe, but unsuccessfully (see p. 11).

From the behaviour of the other three animal trypanosomata (T. IV, V, VI) in the stomach of Glossinæ and Stomoxys, it would seem permissible to say that these three species of trypanosoma are distinct. Unless it can be shown that very material differences in this respect in

one and the same parasite can be brought about by a sojourn in, or a passage through, different mammalian hosts, the fact that T. IV was active in Glossinæ for 100 hours, T. V only 5½ hours, and T. VI for 20 hours after a feed, would lead one to infer that these three trypanosomata were distinct from one another. On the other hand, the question of their identity with any of the known trypanosomata is more difficult to answer.

The "Jinja" disease in cattle, known locally as "Sutoko," associated with the presence in the peripheral blood of the trypanosoma we have called T. IV, may be an acute form of Nagana. From the account of the disease given us by Mr. Grant, the Sub-Commissioner of Busoga, it appears that the cattle, often quite well, may be stricken down and die in 24 hours. Such a course in the case of Nagana in cattle is unusual. Then, again, this Trypanosoma produced in dogs and monkeys a more chronic form of disease than does the *Tryp. brucei;* for example, dogs lived 26, 29 and 43 days after inoculation, whereas two inoculated monkeys lived 39 and 90 days after inoculation, the former of the two dying not of trypanosomiasis alone, but of septic peritonitis. The morphology of T. IV in the blood of diseased cattle was peculiar. As mentioned on p. 18, short "stumpy" forms predominated, the average length being about 12 μ; in addition, many ordinary long forms were visible, average length about 21 μ, and in one film a very large parasite measuring 44 μ (including the flagellum) was encountered. The parasites resemble those described by Dutton and Todd in the disease amongst horses in the Gambia colony—the *Tryp. dimorphon*, whereas the largest one seen resembles the *Tryp. theileri*. (See Plate 1.)

We may sum up, therefore, and state that both morphologically and in its behaviour in naturally-diseased cattle and in artificially infected dogs and monkeys, this trypanosoma is probably distinct from the *Trypanosoma brucei.*

The "East African" disease occurring in a dog which contracted it when with the Abyssinian Boundary Commission, associated with the trypanosoma we have called T. V, may prove to be, and probably is, Surra. Morphologically, in the naturally-infected dog, this trypanosoma closely resembled the *Tryp. evansi.* (See Plate 2.)

The "Entebbe mule" disease, associated with the trypanosoma herein called T. VI, appears to be distinct from the "Jinja" disease (Sutoko), and from the East African. The trypanosoma in the mule's blood showed marked vacuolation, as it did also on several occasions in the blood of inoculated monkeys and dogs. (See Plates 2 and 3.) The parasite often had a very blunt posterior extremity. This trypanosoma, on injection, appeared to be rather more virulent for dogs and monkeys, but less so for rats, than the other two trypanosomata (T. IV and V).

In the stomach of Glossinæ it was found motile 20 hours after a feed, whereas under the same conditions, the T. IV was active 100 hours, and the T. V 5½ hours only.

Section IV.—Is the Trypanosoma of Sleeping Sickness Conveyed by the Tsetse Flies met with in East Africa?

To settle this question one of us (E. D. W. G.) proceeded to East Africa on July 1, 1903, to organise experiments and to investigate the fly belt. Monkeys inoculated with cerebro-spinal fluid from Sleeping Sickness cases were taken from Entebbe to Nairobi, which was selected as an experimental station on account of its central position and freedom from the fly. Dr. C. A. Wiggins was associated with us in the work and after-organisation of the experiments, and continued to watch them for us until their conclusion.

On July 7 we proceeded to Kibwezi (193 miles from coast) to investigate the flies found in the "belt," and to arrange for a regular supply of living specimens being sent to the experimental station at Nairobi. Several varieties of tsetse were caught (these have been sent to Mr. Austen, of the British Museum, for investigation).*

The distribution of the fly appeared to be distinctly "local" in this district, that is to say, the flies were found in particular spots in fairly large numbers, whilst other parts were free from them. The character of the country was similar to that met with in other fly districts. The flies were said to have been very numerous about two months previously (during the rains) and many goats and cattle had died at that time. The Kikamba name for the fly is *Kitangwa*.

The flies having been caught, were fed on a healthy dog at Kibwezi and then sent by train to Nairobi. On arrival at the experimental station the flies for each experiment were fed on a healthy dog, kept for 24 hours, then placed on the infected monkey and afterwards, at the proper intervals, on the healthy monkey.

There were 4 experiments, viz.: (1) An "immediate," (2) 8 hours, (3) 24 hours, (4) 48 hours. For each experiment there was a healthy dog, an infected monkey and a healthy monkey. The object of using a dog was to be absolutely certain that the other variety of trypanosoma, *T. brucei* (to which the dog is very susceptible) was not present in the flies before putting them on the monkeys. The different varieties of flies were not separated in these experiments, as it was considered that, at the present stage, the point of most importance to settle was, whether *any* of the species met with in East Africa conveyed the trypanosoma of Sleeping Sickness.

* Mr. Austen tells me that up to the present no *Gl. palpalis* have been sent to him from East Africa. The flies sent are *Gl. pallidipes*, *Gl. fusca*, and *Gl. longipennis*.—D. N.

The same experiments might be carried out with each individual species. The details of the two positive experiments are given below. It will be seen from these that the tsetse flies met with in East Africa are capable of conveying the trypanosoma of Sleeping Sickness after 8 hours and 24 hours. This is a point of considerable importance, as the belt extends down as far as South Africa and the fly also runs up the great waterways from the coast. Hence should this belt become infected by the trypanosoma of Sleeping Sickness, the distribution of this disease would be very greatly extended.

Experiment 156.—Kikuyu Monkey. "8-hour" Experiment.

July 17, 1903. Feeding started.
August 15. Tryp. absent. Mal. present.
August 22. Tryp. absent. Mal. present.
October 1. *Tryp. present.*

The duration of this experiment was about two and a half months, and an average of four or five flies a day fed on this monkey.

Experiment 157.—Kikuyu Monkey. "24-hour" Experiment.

July 10, 1903. Feeding started.
August 15. Tryp. absent. Mal. absent.
August 22. Tryp. absent. Mal. absent.
September 8. Experiment interrupted, as all flies were killed by ants.
October 4. Feeding resumed.
October 25. Blood examined. Tryp. present.
November 4. Monkey brought to Entebbe.
November 9. Monkey died.
Post-mortem.—The organs were all found to be healthy.
Death was due probably to the change of climate.
On an average four flies a day fed on this monkey.

Section V.—Further Observations on the Distribution of the Tsetse Fly in Uganda.

After Col. Bruce's departure we made observations in special areas which had not been previously investigated.

(1) The Busoga (right) bank of the Nile beyond Kakoge ferry. This was searched for a distance of about 20 miles, in Gabula's country, but no tsetse flies were found.

(2) The Nile beyond Lake Albert. The Collector at Wadelai, Mr. W. Y. Wyndham, sent us some *Glossina palpalis* from the bank of the Nile on the Congo side. He was then instructed by H.M. Commissioner to examine the shore of the Lake Albert, and on October 25

the following telegram was received from him: "Just finished tour of Lake Albert, have found tsetse fly prevalent everywhere along coast; details follow by post."

In his letter Mr. Wyndham states that at each of 12 places situated on the shores of the lake (six on the Uganda shore and six on the Congo Free State shore) *Glossina palpalis* was found, and he forwarded specimens of this fly to us from each place. One paragraph in his letter is particularly interesting, so we give it in full. "Mahagi Kabir was interesting, as I found the fly on the banks of a river of some size, unmarked on the maps, called the Kakoi. There was neither forest nor swamp, but the banks were covered with high elephant grass. The fly cannot depend for its existence upon game, as in most of the places in which I found it there was none, or next to none."

Although the *Glossina palpalis* was present all round the Albert Lake, there was, at that time at any rate, no Sleeping Sickness in the district.

(3) The left bank of the Nile, between the Lakes Victoria and Choga, was investigated, including the districts known as Bugerere and Buruli, but no tsetse flies were found.

(4) One *Glossina palpalis* was received from the "White Fathers," said to have been caught near the mission station at Fort Portal, in Toro. As we had hitherto not received any tsetse flies from that district, we asked for more specimens to be caught and sent in, if possible.

Conclusion.

In conclusion, we beg to offer our hearty thanks to Colonel Hayes Sadler, C.B., His Majesty's Commissioner and Consul-General for Uganda, for the assistance he has invariably given us: to Drs. Moffat, C.M.G., Hodges, Wiggins and Ross for their active co-operation in the work of the Commission; to Mr. R. J. Stordy, the Principal Veterinary Officer to the Protectorates, for sending us the dog suffering from the "East African" disease and also for taking the photographs of Sleeping Sickness patients; to Mr. W. Grant, C.M.G., Sub-commissioner for Busoga, for much practical help and information concerning the "Jinja" disease in cattle; to the Sub-commissioners, collectors and other officials of the protectorate, to the bishops and missionaries of the various churches, and to the Prime Minister and Regents of Uganda, for their co-operation in collecting flies for identification; and, lastly, to Dr. A. C. Stevenson, of University College, London, for the sketches illustrating the different forms of trypanosomata described in this Report.

DESCRIPTION OF PLATES.

Plate 1.

Fig. 1.—Film of "Jinja" animal, showing trypanosomata of varying sizes and forms (T. IV). × about 1200.

Fig. 2.—*a*. Filaria from blood of Monkey 241, showing general appearance. × 500.

b. Head end. *c*. Break in protoplasm.

d. Tail end. *b*, *c*, *d*. × 1200.

Plate 2.

a. Trypanosomata in blood of Dog 160 (T. V).

b, *c*. Trypanosomata in blood of Dog 197 (T. VI). (All × about 1200).

The five parasites in the lower half of this plate represent vacuolated and deformed trypanosomata (T. VI) in blood of Monkey 180. × about 1200.

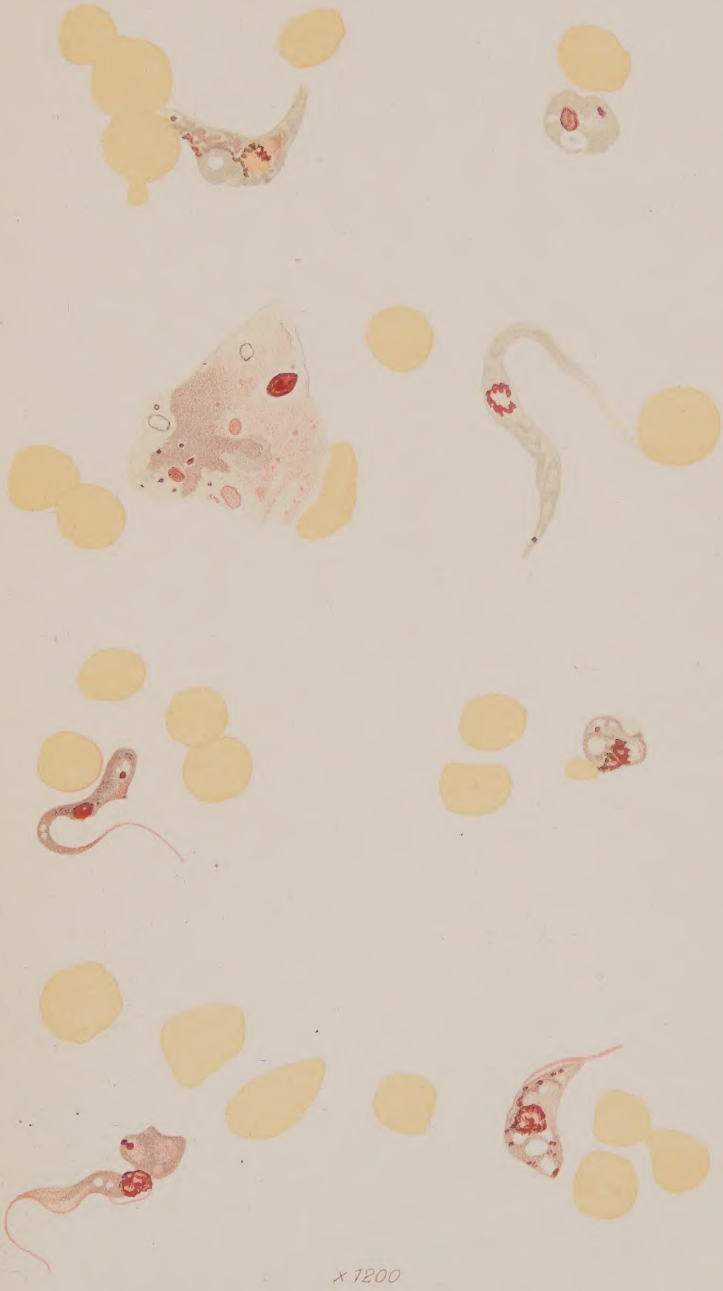
Plate 3.

Various forms of trypanosomata seen in a film of stomach contents of *Glossina palpalis*, 14½ hours after feeding—"Mule," T. VI. × 1200.

West, Newman chrom.

x 1200

West, Newman chromo



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